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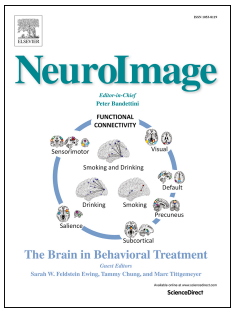

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PII: S1053-8119(18)30207-6

DOI: 10.1016/j.neuroimage.2018.03.012

Reference: YNIMG 14781

To appear in: *NeuroImage*

Received Date: 23 November 2017

Revised Date: 31 January 2018

Accepted Date: 5 March 2018

Please cite this article as: Falahpour, M., Chang, C., Wong, C.W., Liu, T.T., Template-based prediction of vigilance fluctuations in resting-state fMRI, *NeuroImage* (2018), doi: 10.1016/j.neuroimage.2018.03.012.

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Template-based prediction of vigilance fluctuations in resting-state fMRI

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Abstract

Changes in vigilance or alertness during a typical resting state fMRI scan are inevitable and have been found to affect measures of functional brain connectivity. Since it is not often feasible to monitor vigilance with EEG during fMRI scans, it would be of great value to have methods for estimating vigilance levels from fMRI data alone. A recent study, conducted in macaque monkeys, proposed a template-based approach for fMRI-based estimation of vigilance fluctuations. Here, we use simultaneously acquired EEG/fMRI data to investigate whether the same template-based approach can be employed to estimate vigilance fluctuations of awake humans across different resting-state conditions. We first demonstrate that the spatial pattern of correlations between EEG-defined vigilance and fMRI in our data is consistent with the previous literature. Notably, however, we observed a significant difference between the eyes-closed (EC) and eyes-open (EO) conditions finding stronger negative correlations with vigilance in regions forming the default mode network and higher positive correlations in thalamus and insula in the EC condition when compared to the EO condition. Taking these correlation maps as "templates" for vigilance estimation, we found that the template-based approach produced fMRI-based vigilance estimates that were significantly correlated with EEG-based vigilance measures, indicating its generalizability from macaques to humans. We also demonstrate that the performance of this method was related to the overall amount of variability in a subject's vigilance state, and that the template-based approach outperformed the use of the global signal as a vigilance estimator. In addition, we show that the template-based approach can be used to estimate the variability across scans in the amplitude of the vigilance fluctuations. We discuss the benefits and tradeoffs of using the template-based approach in future fMRI studies.

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